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Researchers Study Fire in Space

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Far from a fire department and with nowhere to escape, astronauts caught in a space shuttle fire face few options.

What would they do?

This is one of the questions that a UC Berkeley professor is trying to answer.

Working in the NASA-funded Microgravity Combustion Laboratory, UC Berkeley engineering professor Carlos Fernandez-Pello and his students have set out to better understand how materials burn in space and what can be done to ensure the safety of the astronauts.

Courtesy/Carlos Fernandez-Pello

SPACE SHUTTLE CARGO BAY containing smoldering experiment cruises over the San Francisco Bay.

The eight-year old lab is part of a larger program being conducted by NASA to study the behavior of fire in space. With the International Space Station nearing completion, the possibility of fires harming astronauts or causing millions of dollars in damage to equipment is becoming an increasing worry.

One of three projects being carried out in the lab, the Microgravity Smoldering Combustion project has provided NASA with much useful information.

A nonflaming form of combustion, smoldering is especially dangerous because it is hard to detect and can easily cause fires by overheating cables and insulation.

To study the process, the UC Berkeley team designed a self-contained experimental apparatus that ignites samples of polyurethane foam and then analyzes them with an ultrasound imaging technique.

"Smoldering generally occurs in the interior of the material, so it is difficult to see with a normal video camera," explains Fernandez-Pello. "We use (the ultrasound) to scan the inside of the material, which becomes more porous and easier for the sound to propagate (as the material burns)."

In addition to work in the lab, an important part of the project is conducting experiments aboard the space shuttle.

So far, four series of experiments have been sent up in the shuttle, the most recent in July, and four more are scheduled over the coming year.

Getting to the stage at which an experiment can be sent up on the Space Shuttle, however, requires much preparation.

Courtesy/Carlos Fernandez-Pello

SCIENTISTS conduct microgravity combustion experiments aboard NASA's KC-135 parabolic flight airplane.

"These space flight programs are really lengthy," says Fernandez-Pello. "Each experiment is very expensive, so you have a large ground program."

The process begins with a conceptual design by the lab that is submitted to NASA, which then builds an engineering model.

"We do testing in this airplane that makes parabolic flights, called the 'Vomit Comet', and also in drop towers," says Fernandez-Pello.

Eventually, a mock-up is built, and the astronauts get familiar with the experiment. After a number of safety reviews and a final approval, the experiment is ready for flight.

So far, the experiments have produced a lot of useful information for the scientists.

One of the major findings has shown that smoldering occurs more easily and in smaller samples aboard a spacecraft because of the lower air flow rates and reduced heat losses.

But it is the transition from smoldering to flaming that can be particularly dangerous, so Fernandez-Pello and his team have recently begun working on a second project, called Smoldering, Transition and Flaming, to study this phenomenon.

"Basically, what NASA has done is extend the (smoldering) project and aim to new experiments that will be conducted in the Space Station rather than in the Space Shuttle."

Although the project is still in its infancy, some information has already been uncovered regarding how flames work in space, particularly with regards to the air conditioning systems found in the space facilities.

"There are very low velocity currents of air that replace buoyancy, and what we are finding out is that at these low air flow velocities, combustion is stronger than in normal gravity because less heat is removed from the flames," says Fernandez-Pello. "The air conditioning brings air to the flame like when you are fanning your fireplace, and it burns more intensely than in normal gravity."

In addition to the flaming project, there is also a third one called the Forced Ignition and Spread Test, which studies the flammability of materials.

The experimental apparatus for this experiment consists of a small wind tunnel in which materials are placed and exposed to varying heat fluxes and air velocities.

Started about three years ago, the materials testing program will also conduct its experiments aboard the International Space Station

Currently, there are six other universities also working on experiments for the Space Station.

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